REIMAGINING PRESCHOOL PEDAGOGY: AI-ENHANCED TEACHING THROUGH MULTILITERACIES-INFORMED CURRICULUM INNOVATION

Kallia Katsampoxaki-Hodgetts, Konstantinos Kotsidis, Stamatios Papadakis, Panagiotis Anastasiades
University of Crete, Greece
E-mail: katsampoxaki@uoc.gr, Kkotsidis@edc.uoc.gr, stpapadakis@uoc.gr, anastasiadis@uoc.gr

Abstract

The integration of Artificial Intelligence (AI) into early childhood education raises important pedagogical questions about how to design inclusive, multimodal learning experiences that nurture children's agency and critical literacies. This paper analyzes sixty AI-enhanced teaching scenarios, developed during a national training program, through the lens of Multiliteracies and Learning by Design (LbD). Using thematic analysis, the study identifies how the four knowledge processes–Experiencing, Conceptualizing, Analyzing, and Applying–are supported or constrained by AI-enhanced multimodal activities. Rather than assessing the teachers' intentions, the study highlights the emergent pedagogical affordances and the potential of the LbD model for crafting flexible, inclusive, and socially embedded learning experiences within the Early Childhood Education (ECE) curriculum. The findings suggest that strong foundations are already in place for responsibly integrating Artificial Intelligence (AI) tools into preschool learning environments, while affirming that a systematic, multimodal, and culturally sensitive approach fosters early critical literacy development.

Keywords: *multiliteracies, learning by design, artificial intelligence, early education*

Introduction

The rapid expansion of digital technologies and their integration into educational settings presents new opportunities and challenges for curriculum design, particularly in Early Childhood Education (ECE) (Lampropoulos & Papadakis, 2025). Among the emerging tools reshaping learning environments, Artificial Intelligence (AI) offers novel pathways for knowledge creation, multimodal representation, and playful inquiry, even among young learners (Anastasiadis et al., 2024; Aravantinos et al.,2024; Uğraş et al., 2024; Katsampoxaki-Hodgetts et al., 2024). Simultaneously, the need to address the linguistic, cultural, and multimodal diversity of young learners has prompted a shift toward pedagogical models such as Multiliteracies (Cope & Kalantzis, 2009, 2020; New London Group, 1996). Learning by Design (LbD), grounded in Multiliteracies theory, offers a reflexive, non-linear framework based on four knowledge processes, i.e., Experiencing, Conceptualizing, Analyzing, and Applying, that supports learner agency,

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creativity, and socio-cultural connection before and after AI (Gee & Zhang, 2024). Early childhood settings, traditionally characterized by playfulness, experiential learning, and creativity, must now navigate the responsible integration of AI without compromising these core attributes. Designing AI-enhanced learning scenarios thus demands careful pedagogical planning that simultaneously nurtures children's agency, multimodal literacies, and cultural awareness (Katsampoxaki-Hodgetts et al., 2024).

As recent scholarships suggest, the infusion of AI into early learning environments offers unique opportunities for children to contribute their lived experiences into collective meaning-making processes, transcending the sum of individual knowledge (Zapata, 2023; Gee, 2024). In this context, young learners are positioned as active co-constructors of knowledge, building bridges between firsthand experiences, emerging digital landscapes, and the broader social world.

AI-integrating scenarios involve a deeper pedagogical embedding of AI, where the design and implementation of the learning experience are consciously shaped by the capabilities, limitations, and socio-cultural implications of AI technologies (Katsampoxaki-Hodgetts et al.,2024; Zawacki-Richter et al., 2019). Here, AI is not merely an add-on but becomes a catalyst for rethinking learning processes, promoting critical inquiry, co-creation, and multimodal meaning-making (Kalantzis & Cope, 2020; Zapata et al., 2023). Understanding this distinction is essential for evaluating how early childhood education curricula can responsibly incorporate AI to foster agency, reflexivity, and culturally sensitive literacies from an early age.

Despite growing interest in integrating AI into early childhood education, there remains a lack of research on how such technologies can be meaningfully embedded within pedagogies that prioritize multimodal, inclusive, and culturally responsive learning. This gap highlights the need for frameworks that support educators in designing AI-enhanced activities that nurture young children's agency and critical literacies.

The aim of this study was to analyze preschool teaching scenarios that incorporate AI, focusing on how they reflect the principles of Multiliteracies Pedagogy and Learning by Design. The study seeks to identify both pedagogical affordances and challenges that arise when AI is integrated into early learning environments.

The research question guiding this study was:

How are the four knowledge processes of Learning by Design manifested in AI-enhanced preschool teaching scenarios, and what pedagogical opportunities arise through the prism of Multiliteracies Pedagogy?

Theoretical Framework

Multiliteracies Pedagogy in Early Childhood Education

The Multiliteracies Pedagogy (MLP), first proposed by the New London Group (1996) and further developed by Cope and Kalantzis (2009, 2020), offers a dynamic, interdisciplinary, and culturally responsive framework for learning and teaching. It positions learners as active meaning-makers navigating diverse linguistic, cultural, and multimodal landscapes. In early childhood education, adopting a Multiliteracies perspective is especially critical, as children's earliest educational experiences shape their developing identities, critical capacities, and creative expression (Gee, 2007).

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The MLP framework recognizes four interconnected knowledge processes:

- Experiencing (Engaging with the known and the new)
- Conceptualizing (Developing generalizations, classifications of concepts, properties, principles, and terminology)
- Analyzing (Critically examining and evaluating knowledge)
- Applying (Creatively transferring and transforming knowledge in practice)

In this view, learning is neither linear nor hierarchical but emerges from the recursive interplay of these processes within richly multimodal and socially situated environments. In early childhood settings, this approach invites a shift from traditional teacher-centered instruction toward child-centered, participatory, and culturally inclusive practices that honor diverse ways of knowing and expressing (Kalantzis & Cope, 2020).

In this study, the Multiliteracies Pedagogy framework is complemented by the Learning by Design model, which serves as the analytical tool for interpreting AI-enhanced teaching scenarios (see Research Methodology section).

Artificial Intelligence and Multiliteracies in Early Learning Contexts

The integration of AI into early childhood education is still an emerging area of practice and research (Anastasiades et al., 2025; Lampropoulos & Papadakis, 2025). AI tools, when critically selected and pedagogically framed, can offer powerful opportunities for fostering multimodal literacy, inquiry, collaboration, and creative production among young learners. Story generators, image creators, and conversational AI interfaces can expand children's repertoires of symbolic expression, enabling them to engage with diverse modes such as text, sound, movement, visual art, and interactive media (Zapata et al., 2023).

However, the mere use of AI does not guarantee meaningful learning. Without careful pedagogical framing, AI risks reinforcing passive consumption, superficial engagement, or technological determinism. Therefore, a Multiliteracies and Learning by Design perspective provides a necessary critical lens for ensuring that AI is mobilized to support active, reflexive, and socially situated learning rather than displacing the playfulness, relationality, and embodied experiences that are foundational to early childhood development (Gutierrez, 2009; Wohlwend, 2018). In this study, the intersection of AI, Multiliteracies, and LbD offers a fertile ground for reimagining early childhood curriculum design: one that leverages technological affordances to deepen, rather than dilute, children's agency, critical awareness, and creative literacies.

Research Methodology

Design

This study adopted a qualitative research design, employing thematic analysis (Braun & Clarke, 2006) to analyze how preschool educators' AI-enhanced teaching scenarios embodied the knowledge processes proposed by the Learning by Design (LbD) framework, viewed through the lens of Multiliteracies Pedagogy. The research was conducted in April 2025 and focused on scenarios developed as part of a national professional development program in Greece. The approach was interpretive, grounded

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in socio-cultural theory, and aimed to uncover pedagogical patterns within the dataset. Rather than evaluating the educators' original intentions, the analysis focuses on the pedagogical affordances and constraints emergent in the design and description of the scenarios.

Context and Data Collection

The dataset consisted of sixty (60) written teaching scenarios developed by preschool educators who participated in a 400-hour national professional development program focused on the pedagogical use of Artificial Intelligence and digital technologies. Each scenario included a description of learning objectives, a sequence of planned activities, the AI-enhanced digital and non-digital tools employed, and anticipated student actions and responses. The scenarios were submitted as part of the program's final portfolio requirements and were anonymized before analysis.

Analytical Framework

Thematic analysis was guided by the four knowledge processes of the LbD model (Kalantzis & Cope, 2020): Experiencing (personal and new experiences), Conceptualizing (naming concepts and theorizing relationships), Analyzing (functional and critical examination of knowledge), and Applying (appropriate and creative transfer and transformation). Initial coding focused on identifying explicit or implicit references to these processes. Through iterative rounds of analysis, the data were organized into sub-themes reflecting multimodal engagement strategies, uses of AI tools, and the socio-cultural positioning of learning activities.

The analysis unfolded as a continuous and iterative process. It began with familiarization, where repeated readings of the scenarios allowed for a deep understanding of their overall structure, intentions, and pedagogical orientation. Building on this immersion, initial coding was conducted by developing thematic codes directly aligned with the four knowledge processes of the Learning by Design framework. As coding advanced, the emerging themes were further refined into sub-categories, including patterns such as multimodal representations, the use of personal narratives, the presence of critical discussions, and the integration of AI-assisted creativity. Through reflective synthesis, these categories were interpreted not simply as isolated practices but as indicators of broader pedagogical trends and opportunities within the early childhood education context. To support the systematic organization and retrieval of data throughout this process, NVivo 14 software was employed, enabling a more rigorous and transparent analysis of the collected scenarios.

Learning by Design as an Analytical Lens

Learning by Design (LbD) operationalizes the Multiliteracies epistemological framework into a flexible and reflexive model for curriculum design. By emphasizing knowledge as an active, situated, and transformative process, LbD aligns with contemporary visions of early childhood learning that value agency, play, exploration, and the social construction of meaning.

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The LbD framework identifies four pedagogical knowledge processes:

- Experiencing the Known and the New: Engaging children's lived experiences and introducing new encounters that challenge or expand understanding.
- Conceptualizing by Naming and Theorizing: Encouraging children to recognize patterns, develop conceptual categories, and articulate emerging understandings.
- Analyzing Functionally and Critically: Supporting children in exploring how things work and why they are the way they are, including social, cultural, and ethical dimensions.
- Applying Appropriately and Creatively: Enabling children to transfer knowledge across contexts and to reframe or redesign meanings in new ways.

In applying LbD to preschool AI-enhanced teaching scenarios, this study examines how digital technologies, particularly AI tools, either activate or inhibit these learning processes, with particular attention to multimodal meaning-making and socio-cultural positioning.

The study adopts a reflective and interpretive orientation rather than a frequency-based or purely descriptive one. Emphasis is placed on understanding how teaching practices position young learners as active participants in meaning-making, critical inquiry, and knowledge transformation, consistent with the socio-cultural commitments of Multiliteracies Pedagogy (Cope & Kalantzis, 2009). By examining not only what activities are planned but also how they engage with multimodality, socio-cultural relevance, and critical thinking, the analysis seeks to surface deeper pedagogical potentials for future early childhood curriculum innovation.

Research Results

The sixty AI-enhanced teaching scenarios are aligned with the four knowledge processes of the Learning by Design (LbD) framework: Experiencing, Conceptualizing, Analyzing, and Applying. Analysis revealed consistent patterns in preschool educators' design of AI-integrated activities, demonstrating both supportive and constraining effects on multimodal and socio-cultural learning processes.

Experiencing: Bridging the Known and the New

The analysis of the Experiencing process revealed two key strands: activities that built on children's prior knowledge ("Experiencing the Known") and those that introduced new concepts or experiences ("Experiencing the New"). Educators designed scenarios that connected personal experiences to new learning through AI tools and multimodal resources, aiming to deepen engagement and understanding.

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Table 1
Experiencing: Bridging the Known and the New in Early Education Teaching Scenarios, integrating AI

Type of Experienced Knowledge	Frequency (Number of References)	Pedagogical Perspective	Indicative Teaching Opportunities	Example from Teaching Scenarios
Experiencing the Known	18	Leveraging children's personal experiences and strengthening emotional connection to knowledge.	Narratives and multimodal practices around diseases and microbes, racism and poverty, brushing teeth and microorganisms, family nutrition, and experiences with water.	The teacher shares a personal story about walks among flowers, inviting children to draw their own memories.
Experiencing the New	20	Creating conditions for inquiry, experimentation, and interpretation of new or unknown concepts.	Exploration of plant-based pesticides, virtual microorganism simulations, virtual experiments, and discussions about scientific and technological developments (e.g., greenhouse in Africa).	Through a story, children wonder what they saw and conduct a salt melting experiment to investigate.

Experiencing emerged as a foundational knowledge process across the majority of scenarios, highlighting the centrality of connecting children's personal experiences with new encounters mediated through AI and multimodal tools (Table 1). In many cases, educators intentionally anchored learning in children's familiar worlds, such as memories of playing with water, encounters with different seasons, or everyday phenomena like tooth brushing and nutrition. For example, children were invited to recount personal memories of encountering ice or steam, before experimenting with phase changes in a guided activity. Simultaneously, scenarios also introduced novel experiences through AI-mediated simulations and storytelling, such as virtual explorations of distant ecosystems or creative engagement with digitally generated narratives. Through "Experiencing the New," children encountered previously unknown concepts like biodiversity, renewable energy, or the water cycle in unfamiliar contexts. Importantly, the integration of AI tools, such as story creators, digital exploration platforms, and visual generation applications, served to augment, rather than replace, embodied and emotional dimensions of experience (Table 2). Yet, the pedagogical effectiveness of these experiences depended on thoughtful framing by educators: when experiences were mediated through guided inquiry, critical reflection, or playful dramatization, children's engagement was notably deeper and more participatory.

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Table 2

Ways of Integrating AI in Early Education Teaching Scenarios

Evaluation Method / Assessment	Example (Qualitative Data)
Video creation (Lumen5)	Children create videos with sound and images about local products.
Worksheet & Self/Peer-assessment	Self-assessment and group evaluation using worksheets.
Interactive digital exercises (LearningApps)	Climate change assessment games using LearningApps.
Comparative Concept Maps	Comparing new and original concept maps about climate change.
Theatrical Play	Theatrical play about marine pollution.
Padlet (photo/audio uploads)	Uploading photos and audio recordings on Padlet.
Collage creation (Seasons)	Creating collages about the seasons.
Reflective questioning ('Then-Now')	Reflective thinking routine 'Then I Thought – Now I Know' about seasons.
Letter Writing	Writing a letter to a character about the seasons.
Drawing Activities	Drawing and depicting the seasons.
ELPEIDA Software	Evaluation via ELPEIDA software (bar charts).
Gamified activities (Educaplay, Wordwall)	Assessment through gamified activities on Educaplay and Wordwall.
Evidence-based reflection (K-W-L-H)	Using K-W-L-H diagram for reflection.
Story creation (StoryJumper)	Creating digital albums with StoryJumper.
Reflective group presentation & discussion	Group presentation and reflective discussion of creations.
Flexible grouping and formative assessment	Flexible grouping and use of K-W-L-H strategies.
MagicSchool AI & Canva	Using MagicSchool AI and Canva for digital board creation.
Quizizz	Online quiz assessment using Quizizz.
Wordwall games	Interactive Wordwall games about volunteering.

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Quiz (Quizziz, emotions)	Emotion-focused quiz on Quizziz.
Adobe Spark Video	Video creation about emotions using Adobe Spark.
Observation and Interviews	Observation and interviews for assessment.
Portfolio of Student Work	Collecting student work in portfolios.
Rudolph AI feedback	Feedback from AI (Rudolph AI).
Four Season Box Activity	Four Season Box activity.
Canva Concept Map	Creating digital concept maps with Canva.
Theatrical dramatization & Pixel Art (ELPEIDA)	Theatrical dramatization and Pixel Art creation via ELPEIDA.
Kahoot Quiz	Knowledge quiz with Kahoot.
LearningApps Multiple Choice Games	Multiple choice games using LearningApps.
KWLH Diagram (digital)	Filling digital KWLH diagram.
ChatGPT Questionnaire	Evaluation questionnaire created with ChatGPT.
Parent feedback (blog comments)	Parent feedback through blog comments.
VoiceMod & Fliki AI (colors/emotions)	Expressing emotions through color and sound with VoiceMod and Fliki AI.
Mindmap & Kahoot	Mindmapping and Kahoot evaluation.
NightCafe Image Creation	Image creation using NightCafe.
ChatGPT-created Multiple Choice Questions	Multiple choice questions generated by ChatGPT.

Table 2 presents a variety of AI-enhanced assessment and activity methods designed by preschool educators. The data show that educators integrated a wide range of digital tools, including video creation, interactive quizzes, reflective activities, and multimodal storytelling, demonstrating an emphasis on multimodal engagement and formative assessment.

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Conceptualizing: Building and Structuring Meaning

The Conceptualizing process focused on how children organized and structured knowledge using AI tools. The analysis identified a range of strategies from simple classification tasks to more complex mind mapping and inquiry-based activities.

Table 3

Conceptualizing: Building and Structuring Meaning in early Education Teaching Scenarios integrating AI.

Conceptualization Practice	Frequency	Example from Scenarios
Creating mental maps	21	Children create a mental map recording their views on 'volunteering' using Coggle.
Grouping and classifying objects	18	Children describe characteristics of squares and rectangles and compare them.
Investigating and consolidating concepts	26	Discussion in plenary after viewing a video to elicit children's thoughts.
Comparative analysis and inquiry questions	17	Comparing similarities and differences between squares and rectangles.
Brainstorming and clarification	22	Guiding children to answer an inquiry question collectively.
Using thinking routine questions	14	Using 'See-Think-Wonder' thinking routine.
Connecting new knowledge with prior knowledge	20	Recording newly acquired knowledge in a concept map.

As shown in Table 3, the scenarios demonstrated varied degrees of success in fostering conceptualization, the process through which children organize, name, and theorize knowledge. On the one hand, educators frequently employed strategies such as the creation of mind maps, classification activities (e.g., sorting seasons or geometric shapes), brainstorming sessions, and guided discussions to scaffold conceptual understanding. Digital tools like Coggle, Kidspiration, and Canva were utilized to support the visual organization of ideas, enabling children to construct conceptual relationships multimodally through images, colors, and words. In stronger examples, conceptualization was embedded within inquiry-based approaches: children compared their initial and revised understanding of environmental concepts after engaging with AI-generated videos or simulations.

However, the analysis also revealed that in approximately one-third of the scenarios, conceptualization remained surface-level. In these cases, activities were limited to nominal labeling ("this is evaporation") without encouraging deeper theorization or relational thinking.

Analyzing: Fostering Early Critical Awareness

The Analyzing Knowledge process focused on how children were encouraged to engage in both functional and critical examination of knowledge. The scenarios

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demonstrated varied approaches, including prompting children to explore how AI tools work and fostering early critical literacy through activities that compared human and AI-generated outputs. Although Analyzing is typically considered a challenging process to develop in early childhood education, the analysis highlighted several creative strategies educators used to introduce questioning, verification, and reflection into their lessons.

Table 4

Analyzing: Fostering Early Critical Awareness in Early Education Teaching Scenarios, integrating AI

General Category	Frequency	Indicative Example from teaching scenarios
Critical Analysis	12	Children verify ChatGPT's greetings in different European languages by cross-referencing with books, dictionaries, and Google.
Critical Analysis	9	Children are encouraged to question and not accept what they see uncritically.
Critical Analysis	8	Children compare their self-created travel stories to those generated by AI.
Functional Analysis	11	Children search on ChatGPT without keywords to understand how search inputs affect results.
Functional Analysis	10	Children ask questions to a fictional AI painter and compare painting styles across eras and themes.
Functional Analysis	7	Children compare AI-generated images of a grandmother's life based on different prompts.
Critical Analysis	7	Children create a drawing or short story and compare it with the AI-generated version on the same theme, discussing similarities, differences, and how AI can assist learning.

Some of the most promising examples involved activities where children were encouraged to compare their own creative outputs, such as drawings, narratives, or posters, with those produced by AI tools. In these cases, children discuss similarities, differences, biases, and missing elements, prompting early reflections on how knowledge and representations are constructed. For instance, in one scenario, children created personal stories about the seasons and then compared them with AI-generated versions, discussing questions such as: "Why do the AI stories seem similar? Are they missing some feelings or ideas we included?" Another activity engaged children in evaluating translations produced by AI for cultural appropriateness, encouraging critical thinking about language use. These activities exemplify the Multiliteracies emphasis on critical framing, urging learners not only to absorb information but to interrogate its origins, perspectives, and implications (New London Group, 1996). Moreover, they operationalize Analyzing Critically and Functionally, as children recognize both the technical workings, and the socio-cultural meanings embedded in texts and images (Cope & Kalantzis, 2009). Nevertheless, the integrated analysis revealed that critical analysis practices appeared infrequently (in roughly 20 out of 60 scenarios) and often depended heavily on educator prompts.

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Applying: Creating New Meanings through Multimodal Design

The Applying process captured how children used knowledge creatively and meaningfully across new contexts, often through multimodal design and production. The scenarios featured a variety of activities where children transferred and transformed their understanding by creating stories, engaging in dramatizations, conducting experiments, and developing digital artifacts with the help of AI tools. The analysis showed that educators frequently designed opportunities for children to apply concepts in hands-on, imaginative ways that connected scientific understanding with emotional and social themes, reinforcing the Learning by Design model's emphasis on knowledge transformation.

Table 5

Applying: Creating New Meanings through Multimodal Design in Early Education Teaching Scenarios, Integrating AI

Epistemic Design	Knowledge Process	Frequency (*n* = 60)	Example from teaching scenarios
Story creation for concept familiarization (Storytelling)	Applying the Known	41	We begin with a story about a raindrop traveling the world.
Children's personal narratives/experiences	Applying the Known	28	Children recall where they have seen ice or steam in daily life.
Theatrical play based on content	Applying the Known	33	We transform into raindrops and move like changing water.
Introduction of scientific terms and concepts	Applying the New	49	We introduce the terms 'evaporation,' 'condensation,' through a video.
Viewing and analysis of educational video	Applying the New	52	We watch the droplet's journey video and explain changes through drawings.
Experimentation/Observation of phase change	Applying the New	45	We place ice cubes under the sun and observe what happens.
Reflective questioning with teacher support	Applying the New	19	The teacher asks: 'What would happen if there were no sun?'
Linking with social/emotional themes (e.g., friendship)	Applying the Known	27	The raindrop meets new friends – we discuss feelings about losing a friend.

The knowledge process of Applying was strongly represented across the dataset, affirming the commitment of many educators to foster children's agency in generating new meanings, not merely consuming information. Children engaged in a variety of productive tasks that embodied Applying Appropriately and Creatively, including:

- Designing collaborative storybooks using StoryJumper
- Creating virtual museums of environmental artifacts using Canva and Padlet
- Producing digital posters and short videos expressing scientific or emotional themes

For example, children were invited to produce alternative narratives that combined scientific concepts (e.g., water cycle processes) with emotional and social themes (e.g., making new friends, experiencing loss).

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Discussion

The findings of this study affirm that AI integration into early childhood teaching scenarios offers meaningful opportunities for fostering multimodal, inclusive, and critically engaged learning. Consistent with prior research (Anastasiadis et al., 2024; Zapata et al., 2023), the scenarios demonstrated that AI tools were frequently used to enrich experiential learning through storytelling, simulations, and interactive media. These strategies supported children's engagement with both familiar and novel content, echoing Gutiérrez and Rogoff's (2003) emphasis on expanding children's "funds of knowledge" in culturally responsive ways.

Conceptualization practices, as highlighted in the results, showed a range of success. The strong use of digital concept mapping, inquiry-based discussions, and visualizations mirrors findings by Jiménez-Aleixandre and Erduran (2007), who argue that early science education benefits from scaffolding that supports children in making conceptual connections. However, the present study also revealed that some scenarios limited conceptual work to surface-level naming, reaffirming concerns noted by Cope and Kalantzis (2015) that deep learning requires iterative cycles of reflection and theorization.

A notable strength emerged in how educators designed analyzing activities. Although Analyzing is widely regarded as difficult to foster in early childhood settings (Luke, 2018), many scenarios succeeded in inviting children to critically evaluate AI outputs, compare their own creations with those of AI, and question digital representations. These practices align with the Multiliteracies framework's call for critical framing (New London Group, 1996) and reflect emerging scholarship (Gee & Zhang, 2024) emphasizing that young learners can develop early critical literacies when properly scaffolded. Nevertheless, as Wohlwend (2018) also cautions, the integration of critical discussions must become routine rather than exceptional; otherwise, critical thinking remains peripheral.

In the Applying process, the study found compelling examples where AI was positioned as a creative partner rather than a passive tool. Children's multimodal productions—whether digital stories, dramatic reenactments, or creative artworks—illustrated the potential of AI to enhance expressive and socio-emotional learning. This supports Wohlwend's (2018) vision of young learners as "designers of social futures." However, the data also suggested a risk: without sufficient pedagogical framing, there is a danger that AI-supported creation may become ornamental rather than transformative, a concern echoed by Gutiérrez (2008) in her critique of surface-level digital engagement.

One persistent challenge across the dataset was the need for deeper integration of critical literacy around AI itself. While many scenarios utilized AI to augment learning, fewer addressed the ethical, social, or cultural implications of AI use. This gap points to the necessity of extending beyond functional digital literacy towards what Gee (2024) describes as "cybersapien literacy," which involves understanding AI as both a technical tool and a socio-cultural actor.

Many scenarios reflected an understanding that application is not about mechanical reproduction but about re-designing meaning in novel contexts (Kalantzis & Cope, 2020). In the strongest cases, AI tools were positioned not as authoritative sources but as creative partners, with children critically evaluating and modifying AI-generated outputs to better express their intended meanings.

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In sum, the study's findings are largely congruent with existing literature but also highlight key areas for pedagogical development: scaffolding deeper conceptual engagement, embedding critical reflection systematically, and leveraging AI not only for technical enhancement but also for socio-cultural and ethical inquiry. Future research should continue exploring these dimensions, potentially integrating broader theoretical lenses such as posthumanist perspectives (Zawacki-Richter et al., 2019) to further interrogate AI's role in early learning environments.

Limitations and Implications for Practice and Further Research

While this study provides valuable insights into the pedagogical dynamics of AI use in early childhood education, certain limitations must be acknowledged. The analysis focused on written teaching scenarios rather than observed classroom practices, which limits insights into real-world enactment. Additionally, while educators were well-trained, their AI integration practices remain emergent. To strengthen these outcomes, professional development should focus on equipping educators with strategies for embedding critical digital literacy and ethical inquiry into AI-enhanced activities. Finally, the study reflects a national context, which may affect its broader applicability.
Future research should explore the enactment of such scenarios in real classroom settings and consider cross-cultural comparisons. Table 6 summarizes the observed potential and offers practical recommendations for further research and development. Moving forward, professional development initiatives should emphasize scaffolded critical engagement with AI and encourage culturally and ethically aware applications. Moreover, activities that compare children's own creations with AI-generated outputs should be enhanced with scaffolded reflective questioning to deepen metacognitive thinking and self-regulation. Educators could also design narrative scenarios that introduce ethical dilemmas, prompting children to reflect critically on AI's possibilities and limitations, thereby developing their technological literacy. Additionally, expanding the use of AI-supported tools to create digital portfolios or emotional diaries would allow children to integrate personal narratives and foster identity-building, while integrating intercultural and community-focused storytelling projects can promote social inclusion and cultural sensitivity, ensuring that learning is both locally meaningful and globally aware. Finally, systematic analysis of AI-generated outputs for potential biases, such as those related to gender, culture, or age, should be embedded in learning activities to raise children's critical awareness of representation and diversity in digital contexts.

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Table 6
Observed Potential of AI-integrating Teaching Scenarios in Early Education and Opportunities for Further Development

Observed Potential	Pedagogical Benefit	Opportunities for Further Development
Comparison of children's creations with AI outputs	Enhancement of metacognitive thinking and self-regulation	Design activities with scaffolded reflective questioning on AI-human comparison
Reflection on AI's possibilities and limitations	Development of critical technological literacy	Introducing narrative scenarios involving ethical dilemmas using AI outputs
Integration of emotional and personal narratives	Support of identity building and emotional meaning-making	Create digital portfolios or emotional diaries using AI-supported tools
Inclusion of intercultural and diverse cultural references	Promotion of social inclusion and cultural sensitivity	Produce community-focused or culturally themed storytelling projects
Avoidance of stereotypical representations in AI outputs	Raising awareness of diversity and critical reflection on representations	Systematically analyze AI-generated outputs for biases in gender, culture, or age representations

Conclusions and Implications

This study analyzed sixty AI-integrated teaching scenarios designed by preschool educators within a national professional development program, using a Multiliteracies and Learning by Design framework to interpret their pedagogical affordances. The findings showed that AI tools effectively supported experiential and conceptual learning, enabled creative multimodal outputs, and, in some cases, fostered early critical awareness. While many scenarios demonstrated innovative practices, particularly in experiential and creative domains, the analysis highlighted a need for deeper critical framing and conceptual scaffolding to fully realize AI's pedagogical potential in early childhood settings. It is apparent in this study that integrating Artificial Intelligence into early childhood education is not merely a technological decision, but a pedagogical one. AI integration in early education can enrich learning when it is pedagogically purposeful, culturally responsive, and critically reflective. By anchoring AI practices within Multiliteracies and Learning by Design frameworks, educators can create inclusive, critical, and culturally responsive learning environments from the earliest years. Future research and professional development must continue to center young learners' agency, imagination, and ethical engagement as we design early curricula for an AI-mediated world.

Declaration of Interest

The authors declare no competing interest.

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